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Abstract
In the archaeological sector, information about finds and related documents is highly relevant, but no information system (IS) is available to manage it. Professionals working in the field are often not used to managing information by means of technology and, moreover, work practices are not standardized. The in-troduction of a new IS to track events and record information in such an environ-ment is therefore a big challenge. An adaptation between technology and organi-zation is then to be expected, in order to find an appropriate form of integration. By adopting a structuration theory perspective, this work analyses the case of a project in which an IS to manage finds was designed, experimented with, dis-cussed, and then developed.

Keywords: IS Implementation, Social structures, Technological structures, Adaptation, Archaeology

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Technology and Organisation: a Case of Mutual Adaptation in the Archaeological Sector

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Abstract In the archaeological sector, information about finds and related documents is highly relevant, but no information system (IS) is available to manage it. Professionals working in the field are often not used to managing information by means of technology and, moreover, work practices are not standardized. The introduction of a new IS to track events and record information in such an environment is therefore a big challenge. An adaptation between technology and organization is then to be expected, in order to find an appropriate form of integration. By adopting a structuration theory perspective, this work analyses the case of a project in which an IS to manage finds was designed, experimented with, discussed, and then developed.

Introduction

Once discovered, an archaeological find (like a jug, a statue, a fragment, or even a site) starts a sort of new "life cycle", throughout which it will cross several, even repeated, events (among them storage, cleaning, restoration, study, exhibition, grouping, or consolidation with other finds …).

Sometimes such actions change the nature of the find (e.g. after a consolidation of fragments found at different moments) and its interpretation (e.g. after a study that details its origin or dating), generating a lot of new information. The traceability of all the events in the life cycle of an archaeological find is fundamental to deepening the scientific contribution received by it, to making the best decision about its management every time, and, in the end, to making sense of its discovery and overall of its expensive conservation.

Despite the relevance of information in the archaeological sector, even to warrant the security and safeguarding of the finds, the retrieval and collection of data related to them does not follow standardized procedures, and neither are they managed through computer-based information systems. The operational procedures are highly diversified, and are specific to each agency, organization, or even

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individual that works on finds. Very often operations follow individual practice or context pressure (like in case of an urgent excavation during works on a railway).

The issue of recording, retrieving, and sharing all the information on an archaeological find and its related documents and photos is further complicated by the presence throughout the life cycle of several professionals (archaeologists, restorers, storekeepers, archivists, photographers ...), who usually work separately, even when their activities intersect. Moreover, these professionals often have low levels of IT literacy.

The introduction of a new computer-based IS in order to track events, by recording all the possible information, is then a big challenge. On the one hand, such a system has to be designed in detail to reach its aims; on the other hand, organizational structures are neither fit (diverse, not standardized procedures) nor ready (novelty of IT use in operations) to adopt it profitably. An adaptation between technology and organization is then to be expected, to overcome these difficulties.

This work analyses from a structuration theory perspective the case of the project named "giSAD – Recouvrement du Potentiel Informatif des Sites Archéologiques Démontés" ("Potential Information Retrieval of Archaeological Mobile Sites"), during which an operational IS was designed, discussed, and finally developed. After the description of the theoretical framework, and of the research methodology, this paper will analyse the project context and history. A discussion on the findings and some conclusions will follow.

Theoretical Framework

The theoretical perspective adopted in this paper is based on Anthony Giddens's Structuration Theory (ST) [1], which describes the relationship between individuals and society [2]. Rejecting the two alternative hypotheses of social structures and human agents' radicalism, Giddens claims that they both draw on each other [1]. ST does not directly address technology. As reported by Jones & Karsten [2] and Poole & DeSanctis [3], the technology artifact is neglected by Giddens. Nevertheless, ST is credited to be a great influence on IS research [2, 3, 4]. Therefore, due to the relevance of IT in organizations' everyday life, some seminal works have attempted to include the IT concept more explicitly [4].

Among all the seminal works that extend and adapt ST, DeSanctis & Poole propose Adaptive Structuration Theory (AST) [5]. AST extends ST by introducing concepts that have found broad acceptance in the IS community [6]: "structural features" ("specific types of rules and resources, or capabilities offered by the system" [1 p. 126]), "spirit" ("the general intent with regard to values and goals underlying a given set of structural features" [1 p. 126]), and "appropriation". Citing Dennis & Wixom [7] and Rao & Jarvenpaa [8], Niederman et al. affirm that AST "has been used extensively as a framework for investigating and consolidating findings regarding Group Support Systems for more than a decade" [9]. Since AST adds constructs to study relationships among groups and technology, it ap-

pears to be a suitable extension of ST for the present empirical case.

According to AST, not only do social structures shape human agency (and vice versa) but technology itself is a source of structures, as it possesses features that can shape the way human agents manipulate information (what Giddens calls "signification" [1 p. 126]). Structures provided by technology can also be described by the spirit, that is, the "official line which the technology presents to people regarding how to act when using the system, how to interpret its features, and how to fill in gaps in procedure which are not explicitly specified" [1 p. 126] (what Giddens calls "legitimation" [1 p. 126]).

When information technology is implemented, complex patterns of behaviours that lead to users' appropriation can be observed. Foreseeing appropriation processes is difficult, as the introduction of a new technology might lead to unexpected outcomes, due to the interplay among social structures, structural features, and human agency. The intended uses of IT may be distorted by users, who appropriate IT for purposes different from those initially intended [10]. Even if the present case deals with a development process (and not with a post-implementation analysis), AST has been adopted because the project also involved software experimentation by the users.

Research Methodology

The unit of analysis this paper focuses on is formed by multiple groups of actors (professionals working in the archaeological field) across the different organizations (the different archaeological departments) involved in the project as partners.

Data for the analysis have been collected by means of direct observation and analysis of documents. One of the two authors of this paper was able to attend all the project meetings and has had, as a result, direct access to primary sources of data. Moreover, minutes of meetings and copies of relevant project documents were available to both authors for investigation.

Due to the lack of specific guidance on the application of ST [3], the case is analysed using the key concepts of social structures (ST), structural features (AST), spirit (AST), and appropriation (AST). The entire operational method of AST proposed by DeSanctis & Poole [5 p. 131-141] is not adopted, because it appears too restrictive and, furthermore, it seems not to have been literally adopted in other works. The methodology rather relies on the sequence of events and the three groups of actors (promoters and leaders, technology experts, and final users) used by Boudreau & Robey [11] to analyse the implementation process of a technology. Such events include: the "inertia" (that Boudreau & Robey [11] assimilate to the kind of technology use described by Orlikowski [12]: users try not to modify their existing way of doing things), the "reinvention" (users develop new practices in order to accomplish their work using the system, despite the problems and limitations of the technology), and the "improvised learning" (the transition process in between, through which users acquire knowledge of the system in a that is

is not planned or anticipated).

Case Description

The case analysis begins with a description of the institutional context of the project, together with its aims and characteristics. As already stated, by following the approach of Boudreau & Robey [11], the project history is then reported in three steps: initial inertia, improvised learning, and reinvention of the IS.

Project context and characteristics

In 2001, the Italian autonomous Region Valle d'Aosta, by means of its Co-financed Projects and Research Direction under the Monuments Department, promoted a project named giSAD, co-financed by the European Union. A partnership was established with other six regional Monuments Departments, both Italian and European (from France, Portugal, and Spain). Even though each partner's context was different (in terms of laws, practices, resources, size of the territory, number of finds), they operated in the same field (archaeological heritage management), in a scenario similar to the one described at the beginning of this paper.

Summarizing, in the finds management, the organizational structures (like procedures, workflows, and hierarchies) were both not strict and not incontrovertible, whereas the technological ones did not substantially exist (information about a find or an event was collected only in some cases and on paper registers).

The project [13] had the aim of designing and developing an operational IS addressing multiple objectives, common to all the partners: the exploitation of the huge amount of finds not studied, the availability of much more information based on more trustworthy data, an improvement in resources' usage, the achievement of a higher finds protection, and a reduction in management costs. In the background, the initiative promoters also had more general intents (the "spirit" as in DeSanctis & Poole [5]), which can be classified in three dimensions (see table 1).

Table 1. Dimensions of the intents characterizing the "spirit" of the initiative

Integration	Promoting continuous co-operation among the diverse professionals, through the use of the same platform
Knowledge management	Fostering the creation of knowledge through the availability and sharing of much more information
Ease of adoption	Minimizing the initial impact on users' daily practices and the changes in organizational structures (roles, rules …)

In order to point out the human agency in the emergence of structures, the persons intervening in the project can be classified in three groups (see table 2). In this context, the role of each individual appears hugely relevant, because of the

multiplicity of involved disciplines and the high level of everyone's specialization.

Table 2. Groups of actors involved in the project

Project promoters and leaders (PL)	Director and project local leader of the seven departments; global project leaders
Technology experts (TE)	Persons in charge of the drawing of technical aspects of the system
Final users (FU)	Different professionals of the seven departments

Taking into account the innovation brought into the environment by the project, giSAD was planned involving several phases and stages for presentation and discussion with the users of the outputs produced so far (see table 3). Also for this reason the project took a long time, ending with the final IS development in 2007.

Table 3. Phases of the project with outputs and actors involved (summarized)

Phases	Outputs	Who
1. Analysis of practices and needs	Set of information needed (on the characteristics of finds, depots, archives, events …); thesauri for each piece of information; map of the events to be managed	PL, FU
2. Preliminary design of the system (performed only on the basis of documents)	Documents including technical solutions (database model, structure of the software, hardware …) and new workflow model	TE
3. Trial of pilot software (pre-existing)	Acceptance and hints by the users about this software (limited to some functions in respect of the target one)	FU
4. Discussion on the preliminary design and trial results	List of comments, suggestions and criticism by the users, both on pilot experience and new software design	PL, TE, FU
5. Revised software design	Detailed project to proceed as the system development	TE, FU
6. Development	Final software to be implemented	PL, TE

Initial inertia

When the project started, almost all the users were very curious about the possibility of innovating in their work ("it's time to have more modern and efficient tools to improve our work"). At the same time, they were not at all used to resorting to managerial software (keying in each datum, retrieving information) and to cooperating with other professionals (both from the same and different fields) in their tasks.

The users then began the planned trial of pilot software with great interest and

some difficulties, as with any like innovation. Such software had been developed some years before by the cited Direction of the Region Valle d'Aosta with similar aims, but a less broad perimeter than that to be realized by the giSAD project.

The technical experts were introduced to the project only at the end of the analysis phase, without any previous contact with the final users. They then produced the preliminary design of the system only on the basis of the available documents. Both for this reason, and for their cultural bias, they stressed the security and efficiency objectives by pursuing total process certainty, data completeness, and trustworthiness. Moreover, they paid much attention to the issue of distributing the same software to several partners in partially different situations. Therefore, they proposed a rational design, where technical structures (structural features [5], like data model, workflow model, architecture of the system, mandatory data) featured strongly, then involving a correspondent organizational structuration (in terms of procedures, flow of events, task content, and so on).

Improvised learning

The central phase of the project was devoted to the presentation and discussion with the users of the preliminary study elaborated by the technical experts, and to the examination of the reactions of the same users after the pilot trial.

Regarding the former, the final users generally noticed that it tended to force them too much in many relevant aspects: a restrictive data model ("I could guess that an internal automatic code can help *you* to univocally identify a find, but *I* need a mnemonic code created *by myself*"); standardized forms, unsuitable for anyone in particular ("you put that data in this form, I don't know to be used by whom, but I don't need them and they generate confusion to me"); a set of mandatory data ("we cannot key up that data at all times at this stage of the process, even if it would be both correct and useful"); and overall workflow rigidity ("yes, we agree, yours would be an ideal flow, but we can very hardly follow it. Let's think on an open excavation: we must bring away all the finds in a while, no matter about the complete registration of their data"). Structural features of the technology were then rejected by the users.

Similar comments came out during the evaluation of the pilot trial. Even though this prototype was developed to collect a lot of information on a find, useful for many users, it was designed to support the restoration activity. For this reason, its concept and forms were especially conceived to meet the restorers' needs. Furthermore, this software presented some enforcements, such as for the workflow model and the introduction of the finds' parcel concept, unusual for most users.

The trial of the pilot was then abandoned by many users before the forecasted term. At the same time, however, having experienced the use of computerized systems to record data, some users started to create individual shadow systems, by using a spreadsheet or a database on their own PCs. As could be expected, every single data collection was different in structure, codification, and completeness.

Reinvention

The technical experts learnt many lessons during the several meetings with the users, mainly the specificity of the archaeological sector in terms of the organization

and variety of the cultures. At the same time, the relevance of the issues proposed by the users gave new strength to the dimension "Ease of adoption" of the original spirit, mitigating the weight of some other objectives for the technical experts, and also for the promoters and leaders. All these factors led to a new, less prescriptive, concept for the system, which was designed together with the users, involving many changes in the technical structures:

- an extensible "core" data model, including information common to all the partners, was designed: any user has the chance to obtain new fields in some cases (i.e. for finds' codes), which will automatically appear in the specified form;
- the set of mandatory data in each situation was reduced to the minimum (e.g. a find can be registered initially in the system without the specification of its material or discovery location);
- forms and navigation tools were differentiated on the basis of each professional habit, leaving at the same time the option to add data or change their position;
- the workflow model was deconstructed, becoming a collection of single events: users can insert data on a new find starting from the event considered more appropriate in that case, and then proceed with any other event (or stop there).

As regards this last point, having lost the track-recording feature implicit in any workflow while still being the traceability of a find fundamental, a new function to rebuild each find history ex post was conceived. It retrieves and reports on a timeline all the data about treatments, movements, and other activities related to a find.

Discussion on the Findings

The giSAD project is a valuable example to shed light on the interplay of human actors and technology across the three phases described by Boudreau & Robey [11]. The project history shows the phase of technology radicalism, producing a system whose structural features were not aligned to social structures, finally leading to signs of rejection. From this perspective, the actors in the giSAD project show behaviours compatible with the constructs and outcomes of ST and AST.

Nevertheless, the human actors (especially the end-users) in the giSAD project have also shown another aspect. During the improvised learning phase, the users started to show patterns of unfaithful appropriation [5], but instead of using the system in a different manner from the planned or intended one [10], they decided to reject the artifact completely. However, as they supported the spirit of the giSAD project [5], they appropriated the main concept of the system, creating their own shadow systems.

Then, the improvised learning phase outcomes helped the technological partners and users to converge to a less restrictive [5] reinvention [11] of technology. The new structural features [5], described in the previous paragraph, played a major role in this phase and increased their chance of fitting the social structures.

Conclusions and Limitations

This paper analyses the interplay of technology and organization in the giSAD project, through the study of the process of designing, evaluating, and fixing up of an IS addressed to the management of archaeological finds.

The first element of novelty of this paper lies exactly in the IS analysed, which has been the first, and so far the only, system devoted to archaeological finds management. The second novel element is the adoption of the ST and AST perspective to analyse the whole development process of an IS, instead of the usual post-implementation study.

The adopted theoretical perspective also seems to be suitable in such a case, since its constructs fit the reality of the empirical case and contribute interesting insights on the action of the actors involved in the giSAD project. Due to the relevance and novelty of the case, further research will be addressed to deepening the findings, and to grasping the whole scientific contribution of this project.

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